ogy in the University of Alabama to take the place recently vacated by Mr. James J. Durrett.

DR. F. B. DAINS has resigned the professorship of chemistry in Washburn College to accept an associate professorship of chemistry, in charge of organic chemistry in the University of Kansas.

PROFESSOR KARL PEARSON, F.R.S., has been appointed to be the first occupant of the chair of eugenics in the University of London, established by the legacy bequeathed for that purpose by the late Sir Francis Galton.

DR. ERHARD SCHMIDT, professor of mathematics at Erlangen, has been called to Breslau.

DISCUSSION AND CORRESPONDENCE

THE AIR WE BREATHE IN BUILDINGS

TO THE EDITOR OF SCIENCE: In a recent number of SCIENCE Dr. Gulick asks several questions with regard to the behavior of aqueous vapor in the air, and particularly as to the reason why air when heated becomes drier. All of his questions could be answered by any competent physicist, or could be resolved by reference to any good text-book of physics or of meteorology. But unfortunately, in these days of over-specialization, the language is apt to be too technical, or in the text-books the information too scattered, to be readily found and comprehended by the general reader. Hence the following explanations may be of some use to him and others in a like position.

There are two popular misconceptions, which it is necessary first to dispel. To begin with, few people seem to understand why water is wet. They think, moreover, that because *water* is wet, the same is true of ice and of aqueous vapor. Now this is not the case. Both ice and aqueous vapor are themselves *dry*. They *become* wet, only when they turn to water, ice when it melts, aqueous vapor when it condenses. Hence of the three water is alone wet, and all real moisture is due to the presence of water. So dry is aqueous vapor that it will dry any moist object that it comes in contact with, just as would superheated steam or a dry gas, which in fact are only other names for the *same* thing. Only, we give the name superheated steam to the vapor when the temperature and pressure are much above those of the atmosphere, as in the case of a steam boiler. Of course we must distinguish between the vapor itself, which is a true gas, dry and transparent, and the cloud or mist into which it condenses, on issuing from a locomotive. Hence it is, strictly speaking, incorrect to talk of the moisture or humidity in the air. There never is any moisture or humidity in the air, unless it be such cloud or mist. The described fallacy therefore consists in identifying things which are different, and distinguishing things which are the same—identifying moisture, humidity and water vapor—and distinguishing water-vapor, superheated steam, and dry gas—which are the same.

The second misconception consists in speaking of the *air* as moist or dry—an error not likely to be dispelled by the language of the text-books, which include sections on the "Hygrometric Condition of the Atmosphere." Dr. Gulick falls victim to this misconception when he seeks to explain the apparent drying of the air on heating as due to some *action* of the air on the contained moisture. Thus he says (p. 327), that on heating the air from 32° to 70°—"It appears that one of two things must have happened—either the heat must have contracted the existing moisture or the capacity of the air for moisture has been vastly increased by the rise in temperature." As a matter of fact neither happened, and, moreover, the air had nothing whatever to do with the matter. The same thing would have occurred if the air had been entirely absent, the aqueous vapor alone present. That is to say, aqueous vapor which at 32° seemed relatively moist, would become apparently drier if heated to 70°, whether the space filled by it were simultaneously occupied by air or not. This independence of the substances was first deduced theoretically by Dalton, afterwards established experimentally by Regnault, at least with a high degree of approximation. Hence it is a change in the condition of the aqueous vapor, not of the air, to which the

apparent drying is due, and it is the nature of this change which I must now endeavor to explain.

I have said that aqueous vapor is always dry. How then can it be at times *apparently* drier than at others? The reason is that we judge of the wetness or dryness of a place by the rate at which evaporation occurs therein. This depends upon the elevation of the temperature of the vapor above its dew-point, or that temperature at which it would condense. Suppose we had a hollow vessel enclosing a perfect vacuum. Now introduce a small amount of aqueous vapor at 32° temperature. The vapor will immediately expand until it fills the whole space, and by the heat vibration of its molecules will exert a certain pressure against the sides of the vessel. If now we introduce some more vapor, the latter will likewise expand and the pressure will be increased. But at 32° the vibrational energy of the molecules is limited. If we keep on adding vapor we shall presently so increase the density that this energy can no longer keep the molecules separate. Some of the vapor will condense. There is then a maximum density or pressure, which, so long as the temperature remains at 32°, can not be exceeded. The vapor is then said to be saturated. Suppose, when we arrive at this point, we raise the temperature to 70°. The heat energy of the molecules is thereby increased, and we shall find that we can now put in considerably more vapor before the limiting density and pressure are reached. Hence the latter rise with the temperature, or, what is the same thing, the dew-point or boiling-point increases with the pressure. Now a moist body must be considered as a source of aqueous vapor. If such a body is put into our saturated vapor at 32° no evaporation from it will take place. If the temperature is raised to 70° the vapor becomes superheated, and more vapor is required to saturate it. The moist body becomes the source of that vapor. Evaporation takes place the more rapidly, the greater the degree of superheat, or in direct proportion as the amount of vapor actually present is in defect of that required for saturation. The ratio of the former to the latter is technically known as the *relative humidity*. Thus the apparent dryness of a place depends solely upon the condition of the aqueous vapor therein, and not at all upon that of the air.

Whenever air is heated for a building it should be moistened; whenever cooled, it should be dried. This is generally appreciated, but unfortunately the arrangements provided are usually inadequate. A very considerable amount of moistening is required. The Sturtevant Company, however, manufactures a heating apparatus in which steam is blown into the hot air current from one of their fans, by means of a nozzle which finely atomizes the steam. This insures good mixing. It is found that with such an apparatus a much lower temperature suffices for comfort, and is also more healthful. In Europe, where the winters are, in general, moister than ours, lower house temperatures are habitual. I spent three winters in Italy, and can vouch for the fact that when the temperature in my study reached 65°, I found it uncomfortably warm. A certain Italian lady, who considered 55° in her own country a comfortable temperature and 60° too warm, finds 70° in this climate insufficient.

The fact that air when cooled increases in dampness is much more noticeable. It is a serious impediment to the use of refrigerating apparatus for cooling houses. Air which at 90° has a relative humidity of only 65 per cent. becomes saturated at 70°. If air thus cooled were admitted to a room, moisture would condense on the walls. Such conditions would naturally be very disagreeable.

Though the above explanations are only a rehash of well-known principles, I hope they may be of some use. In return I wish some one would explain to me just what is the danger of the open window. Why is a little sneaking draught in the house a source of colds and grippe, while a high wind out-of-doors a pleasure and a benefit? This is a problem that has long puzzled me, but perhaps it is a foolish question.

M. MOTT-SMITH

WATERVILLE, ME.